

On the first page, you should have the words "Running head" and then the name of the lab in all caps. Click "different first page" in the header options (in Microsoft Word) to do this. Make sure to select different first page before you type anything into the header on the first page.

Include the page number. you can do this by clicking "Page #" in the header/footer menu of Microsoft Word.

Use Times New Roman or serif font, 12pt size, with 1 inch margins on all sides of the page.

Double space your paper AND make sure to remove any extra spaces between paragraphs. To do this, go to Format, then Paragraph. Where it says "Spacing" put 0s in the "Before" and "After" boxes. Change line spacing to "double."

This is the Title of My Example APA Paper

Megan A. Smith

Rhode Island College

Author Note

The Author Note is primarily for papers being submitted for peer-review. Students writing APA papers for class should ask their instructor whether an Author Note is necessary.

The first paragraph of the author note is for affiliations. I would put: Megan A. Smith, Department of Psychology, Rhode Island College. Here is where you would put affiliations and departments for coauthors, if you have any.

In the second paragraph of the author note, put any grant support that helped fund the writing of the paper.

Finally, indicate how interested people can reach you. I would put: Correspondence concerning this article can be addressed to Megan A. Smith, Department of Psychology, Rhode Island College, 600 Mount Pleasant Ave, Providence, RI 02908. Email: msmith1@ric.edu. It is also customary to include a phone number here.

SHORT TITLE

Now, only the short title in capital letters is in the header. Again, use the different first page function in Microsoft Word.

Abstract

The word "Abstract" goes on its own line centered.

No indent for the Abstract

The abstract is a very brief description of your entire paper. It goes on the second page after the title page, and is the only thing on the second page. It is usually about 120-200 words. First, explain the problem under investigation. Next, tell the reader who the participants were (e.g., college students, 4th graders), and how the experiment was conducted. Then explain the key findings (without mentioning specific numbers), and finally the major conclusions and any practical or theoretical implications based on the data. Because it is a summary of the entire paper, it is usually a good idea to write the abstract last. The abstract should be very specific and concise. It should also be self-contained. If you choose to use an acronym in the abstract, such as the American Psychological Association (APA), you must first define it. This is true even if you define the acronym later in the paper.

Keywords: APA Style, APA manuscript, writing tips, experimental psychology

Pick 4 or 5 key words that describe your study. Think about what readers interested in your paper might search for on psycINFO

Indent 1/2 inch at the beginning of each paragraph

This is the Title of My Example APA Paper

Title of the paper goes on the first line of page 3, centered (not bolded)

The first section of an APA paper is the introduction. Notice that the title is the header for this section. You should not include a header that says “Introduction” when writing an APA paper. In the introduction, you present the topic you will be discussing, include a detailed review of literature that has already been published on the topic, briefly introduce the experiments you will present in your paper (the experiments for which you collected your own data), and finally propose hypotheses for the experiments.

Continue indenting!

In the introduction, it is important to tell a clear story that a general audience will understand. From very early on in the introduction (no later than the end of the first paragraph), your readers should know the topic of your paper, and why your topic is important. The importance of the topic can be theoretical, applied, or both! For example, some researchers study retrieval practice or retrieval-based learning – the act of bringing information to mind, which in turn helps people learn that information compared to common study strategies such as rereading one’s textbook or notes. Researchers may be interested in what exactly happens in our minds when we retrieve information (basic research or theory), and/or how retrieval practice can be used to enhance learning in the classroom (applied). The key is to tell the reader why the topic is important, and to write very clearly so that a reasonably intelligent person with no expertise in your subject could understand your paper. Write for a general audience, and define terms that your readers might not know. For example, “retrieval-based learning” is defined above in case readers are unfamiliar with the concept.

The introduction is also where you describe previous literature. Present the reader with a background summary on what has already been done, and what questions remain open. During the literature review, it is important to relate the literature back to your main topic. Again, the

introduction should tell a story. Avoid starting paragraphs with “Now I will tell you about what Author and Writer (2015) did” or “Author and Writer (2015) did xyz” without explaining how the literature is related to your overall topic. A good rule of thumb is to start each paragraph with a topic sentence that describes what the paragraph will be about. Then, the last sentence of the paragraph should link the information presented in the paragraph back to the main topic of your paper. If you are having trouble, try having a friend read the first and last sentences of each paragraph in your introduction, and then ask them to describe the introduction to you. If they can clearly understand and explain the story you are trying to tell in your introduction, then you are probably in good shape. If they are confused, missing key elements of the introduction, or feel the introduction is disorganized, then you need to work on your topic sentences and the clarity of your story.

It is important to understand how to appropriately cite sources in your introduction, and throughout the rest of your paper. When you cite a source within the body of your paper, it is sometimes referred to as an internal or in-text citation. If there is only one author (e.g., Tulving, 1983), or two authors (e.g., Nunes & Weinstein, 2012), it is easy - you always refer to the paper in the same way: using one or both authors. If there are 3-5 authors on a paper, however, the first time you cite a source you list all of the authors' last names and the year (e.g., Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Karpicke, Blunt, Smith, & Karpicke, 2014; Marsh, Meade, & Roediger, 2003); but after the first time, you mention only the first author by name and then say “and colleagues” or “et al.”, and the year (e.g., Karpicke et al., 2014). Finally, if a paper has six or more authors, then you mention only the first author and refer to the remaining authors as colleagues (using either “and colleagues” or “et al.”) right from the beginning. For example, this is the first time I am citing Angeli and colleagues (2010); however,

because there are seven authors on this paper I can drop all but the first author the first time I cite the reference.

When you are discussing a paper it is okay to use active voice when referring to authors who conducted research. However, when this happens a few things change when it comes to the in-text citation. When listing more than one author, note that whether your author names are in parentheses or in the main body of the sentence will affect whether you use the word “and” or the symbol “&” to connect the authors. Take this example: Nunes and Weinstein (2012) examined the relationship between retrieval practice, proactive interference, and false recall. Notice that I used the word “and” instead of the symbol “&.” The “&” symbol only belongs inside parentheses or in the reference section. I also put the year directly after I mentioned the names, and in parentheses. When the authors’ names are already in parentheses, you would just put the year in the same parentheses after a comma, like this (Nunes & Weinstein, 2012).

It is extremely important to always cite your sources. If you get any information from a source – including paraphrasing something – you need to cite the source. If you do not, then you are plagiarizing. For every reference you include in the body of your paper, you also need to have the full reference in the reference section of your paper. In addition, every reference in your reference section should be mentioned somewhere in the body of the paper. See the example reference section included in this model paper!

When you are including a quotation, there is an extra step to your internal citation. Whenever you are directly quoting a source you need to also include the page number where you found the quotation in the body of the text. For example, Roediger, Putnam, and Smith (2011) wrote about the many benefits of testing. Even though many educators think of tests as assessments, “retrieval practice occurring during tests can greatly enhance retention of the

retrieved information (relative to no testing or even to restudying)” (Roediger et al., 2011, p. 1). If the quotation spans more than one page, then you need to include the range of pages. Roediger and colleagues (2011) went on to write, “retrieval of some information on a test can also lead to easier retrieval of related information, at least on delayed tests” (pp. 1-2). Quotes can be useful, but they should not be overused. Only use a quotation when it is important to show your reader explicitly what someone else wrote. This should be very rare. Otherwise, it is much better to paraphrase with a regular in-text citation. Doing this demonstrates to your reader that you understand what it is that you are writing because you can put it into your own words.

One final note about citing your sources: you never change the order of authors within a citation. The authors determined the authorship order based on the amount of work that each put in, and who was primarily responsible for the publication. So, the authorship order always stays the way it is. However, when arranging multiple citations in a list within parentheses, you put each citation in alphabetical order. So, for example, on p. 4 I cited Dunlosky et al. (2013), Karpicke et al. (2014), and Marsh et al. (2003). I put the citations in this order because the “D” in Dunlosky goes before the “K” in Karpicke. The “M” in Marsh goes last. There is a common misconception that you are supposed to put articles within parentheses in chronological order; that is not the case. The same thing happens in the external reference page at the end of the paper. You put the citations in alphabetical order based on the authors. Note, too, that all but the first authors were dropped in each citation above. For each citation there were more than two authors, and I already cited each of these once with all authors listed.

In the very last paragraph of your introduction, you introduce the current experiments you will be presenting, explain their purpose, and present your hypotheses. If you have done a good job of telling a story throughout your introduction, then you have already identified gaps in the

literature where questions still exist. Here, you explain how your experiment or experiments attempted to answer those questions, or at least portions of the questions. It is tempting to write this section in the future tense, because the experiments are about to be presented, but this section does need to be written in the past tense – since the experiments have already been carried out from the reader’s perspective. When you have described the purpose of the current work, you can briefly describe the method for the experiments. Do not include too much detail, as you want to save the specifics for the method section. In this paragraph you give the reader a taste of your methods, and give them enough information so that they understand your hypotheses. Remember: your hypotheses should be based on the previous literature.

Method “Method” is a level 2 header. Level 2 headers have their own line, are fully left-aligned, and typed in bold. Each word starts with a capital letter.

Participants. In this section, you describe the sample that was used. Make sure to explain who the participants were, how they were recruited, and how they were compensated and for how much of their time. Demographic information, such as the average age of participants, the minimum and maximum age of participants in the sample, sex or gender of participants (depending on what is most relevant for your experiment), and ethnicity are often reported. Follow the norm for your field of research.

Experiment 1 “Experiment 1” is a level 1 header. Level 1 headers have their own line, are centered, and typed in bold. Each word starts with a capital letter.

Design. In this section, define the independent variables and dependent variables. For independent variables, make sure to indicate the conditions within the independent variable, or the range being used if your independent variable (sometimes called a predictor variable) is continuous. Indicate how the independent variables were manipulated, for example using a within-subjects design, between-subjects design, mixed design, factorial design, quasi-

“Participants” is a level 3 header. Level 3 headers are typed in bold, indented, and have a period after them. The text comes right after the period. Words after the first word do not start with a capital letter.

Level 3 header, because Design is meant to be at the same level as Participants (within the Method)

experimental design, and so on. You should also indicate if random assignment was used, and how many participants were assigned to each condition.

Materials. Describe all of the materials used, and how they were created. If previously created measures were used, include the relevant citation. Be extremely specific here: For example, to say that multiple-choice questions were used is not enough. Instead, you should indicate that (for example) 12 multiple-choice questions were created, each with one correct answer and four incorrect alternatives presented in a different random order for each participant. The content of the multiple-choice questions came from lectures presented in class the week before the experiment, but participants had not seen the questions before participating in the experiment. It is common for authors to put sample materials in appendices to give the reader a sense of what the materials were like – but you should usually only do this if you created the materials yourself. If you borrowed the materials from another researcher, cite their paper where they used the materials! Sample materials from Smith and Karpicke (2014) can be found in the Appendix in this manuscript.

Procedure. Now that you have described the people in the study, the design of the experiment, and the materials you used, it is time to put it all together in the procedure. You can think of the previous sections as presenting the building blocks of your experiment. Now, in the procedure, you put the building blocks in order.

By the end of your methods section, there should be enough detail so that a reader could replicate (i.e., recreate) the experiment again exactly as you conducted it. Read and re-read your procedure to make sure that no details are missing. It is best to write a draft of the procedure very shortly after you have conducted the experiment so that you do not forget any of the details.

Scoring. For most research, the data need to be processed in some way before they can be analyzed. For example, in learning and memory research, test data need to be scored. It is customary to explain exactly how the data were scored in the method section of the paper, or sometimes at the beginning of the results section. For example, to score participants' answers to short-answer questions, a researcher might give 0 points for incorrect or missing responses, 0.5 points for partially correct responses, and 1 point for correct responses. To score free recall data, a researcher might split a passage into idea units and give one point for every idea unit correctly recalled. Whatever the method, it should be described in detail here. You can find examples in papers already published in your area. For learning and memory examples, see Roediger and Karpicke (2006a) or Smith and Karpicke (2014).

Results

Level 2 header, because Results is meant to be within the Experiment 1 section (but at the same level as the Method section)

The first step is to mention any Tables or Figures that describe your data. Tables and Figures go on their own pages at the end of the paper, after the reference section but before any Appendices. You can find examples of Tables and Figures at the end of this paper. However, you still need to direct your reader to the Tables and Figures. You might first say: Data from the final assessment test are shown in Figure 1; or overall confidence during the initial learning session is shown in Table 1. Tables and Figures are easy ways to present your descriptive statistics (i.e., means, standard deviations or standard errors). Then, describe the analyses you ran in order to make inferences about your data. You should have run analyses that tested your hypotheses. Always tell the reader what test you ran, and describe in words what the test found. You can then support your statement using the test statistics with degrees of freedom, p-values, and effect sizes.

Here is a simple example: We ran a paired-samples t-test to test whether overt and covert retrieval practice led to different levels of initial confidence during learning. The test indicated that when students were in the experimental group, their recall was higher than when they were in the control group, $t(116) = 4.00, p < .05, d = 0.75, 95\% \text{ CI } [0.37, 1.12]$. We also ran a paired-samples t-test to determine whether there were any differences between the experimental group and the control group on their judgments of how much they had learned. Results showed the two groups did not differ, $t(124) = 0.77, p = .44, d = 0.14, 95\% \text{ CI } [-0.21, 0.49]$.

Here are a few tips when writing your results section. First, always present all of the analyses you ran, even if you did not find sufficient evidence to support hypotheses. Second, always describe what the statistics actually mean in plain language, and then include the statistical values. You can think of the statistics themselves as references. When you make a claim, such as retrieval practice improves learning (Roediger & Karpicke, 2006b) you include a reference to tell the reader where you are getting the information. However, when you presenting your own data, there is no reference to cite. Instead, you collected data and you are analyzing your own data to make claims. Think of the statistics as citations to tell the reader where you are getting the information to make a claim. Third, conditions cannot *do* things; people in conditions can do things. You want to avoid sentences like “the short-answer condition performed better than the study-only condition,” and instead write, “participants in the short-answer condition performed better than did those in the study-only condition.” Make sure your description of the results reflects the way you manipulated the independent variable. The example just mentioned suggests a between-subjects design, because two groups of participants are mentioned. For a within-subjects design, you could say, “participants performed better in the short-answer

condition than in the study-only condition.” No matter what the design, make sure Finally, remember data are plural. Make sure your subject and verb agree in your sentences.

Discussion

Now that the results have been presented in detail in the results section, you will need to briefly describe them again at the beginning of the discussion. How do you make sure this section does not repeat the Results? Well, it needs to be less technical and more of a summary. Start with the most important results first. In the discussion statistics should not be presented; instead, simply describe the results clearly in words. Link the results back to your hypotheses, indicating which ones were supported by your data.

Once you have described the results, describe the conclusions and implications you can draw based on the data. It is important not to go beyond what you can claim based on your specific results, but you do want to draw conclusions. Remember, as scientists we can never “prove” anything. Instead, we can find evidence that supports or does not support a hypothesis.


At the end of the discussion for Experiment 1, describe potential limitations of Experiment 1, and introduce Experiment 2. This section should provide a rationale for Experiment 2, and the design of Experiment 2 should follow directly from the results and limitations of Experiment 1.

Level 2 header

Method

Experiment 2

“Experiment 2” is a level 1 header, as it is not meant to be a part of any of the previous sections. So, it gets its own line, is in bold, and is centered

Level 3 header

Participants. This section is the same it was for Experiment 1. Once again, explain your sample in detail. Also, make sure to note whether any participants in Experiment 2 participated in Experiment 1. If not, then you can say none of the participants in Experiment 2 participated in Experiment 1. If you used the same population and recruitment methods for Experiment 2 as you

did in Experiment 1, you can say so and forego describing those again in detail. However, you will still need to report the specific demographics for this new sample.

Design. This section is the same as it was for Experiment 1. If the design was very similar to that of Experiment 1, you may say the design of Experiment 2 was the same as it that of Experiment 1 with a few changes. Then you should carefully describe the changes. If the design is very different, then just describe the design here as you normally would!

Materials. The same goes for materials. If they are the same materials or very similar, state this. If they are different, describe the materials in detail.

Procedure. Now describe your procedure. You may refer to the procedure from Experiment 1 to explain the procedure for Experiment 2 if they were similar. If they were not, then describe the procedure in detail.

Results

Write the results for Experiment 2 in the same way that you did before. For example: Data from Experiment 2 are shown in Figure 2. First, we ran a repeated measures ANOVA on the final assessment data to determine whether our retrieval formats produced different levels of learning as measured on the final assessment three weeks later. And so on.

Discussion

Here you discuss the results of Experiment 2. Begin by briefly summarizing the results found in Experiment 2. Again, link the findings back to your hypotheses. This section is usually very brief, since you will continue discussing all of your data in the general discussion.

Level 1 header  **General Discussion**

In the general discussion, first restate the key results from all of the experiments. As in the previous discussion sections, you should present the results in words, without statistics. It

may feel as though you are repeating yourself, but that is okay. When readers get to the general discussion, they will expect a concise summary of the key results from all the experiments in the first (or first few, if there were lots of different data patterns) paragraphs.

Then, it is time to go beyond the data. Did your data support your hypotheses? Why or why not? Explain what the results mean, for theory, application, or both. It is also important to make links back to previous literature (and of course provide the appropriate in-text citations). The general discussion is also the place where you discuss limitations of your research (every set of experiments has at least a few limitations), present new hypotheses, and discuss directions for future research. For each limitation mentioned, explain why it is a problem and how it could be addressed in future research. Finally, the last paragraph of the general discussion should be the main takeaway message from your paper.

Hopefully, this resource helps you write your APA manuscript. It is important to understand what information goes in each section, and how to format each section. There are many other resources available to help you write your APA manuscript as well. Landrum's (2013) book on Undergraduate writing is an excellent resource. I particularly recommend the first chapter about telling your scientific story. You can also find answers to any questions you have about APA format in the APA Publication Manual (American Psychological Association, 2009). The Purdue Online Writing Lab (OWL; Angeli et al., 2010) includes many writing tips and updated information about APA format (as well as MLA and CMS formats). In addition, the Purdue OWL created a PDF containing quick citation information (Purdue OWL, 2014). You can find the link to the PDF in the reference section of this paper.

References

American Psychological Association (2009). *Publication manual of the American Psychological*

Association (6th edition). Washington, DC: Author. Book citation. In this case, the authors (APA) are also the publishers

Angeli, E., Wagner, J., Lawrick, E., Moore, K., Anderson, M., Soderlund, L., & Brizee, A.

(2010, May 5). *General format*. Retrieved from Internet citation

<https://owl.english.purdue.edu/owl/resource/560/1/>

Here is an example reference:

Author, A. A., & Writer, T. L. (2015). The title of the source is here: Notice you only capitalize

Take note of the aspects of the reference that are capitalized, in italics, etc.

the first letter of the first word and the first letter of words after punctuation colon, period, exclamation mark, or question mark. *Journal Name*, 1, 34-49.

Callender, A. A., & McDaniel, M. A. (2009). The limited benefits of rereading educational texts.

Contemporary Educational Psychology, 34, 30-41.

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013).

Improving students' learning and comprehension: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*, 14, 4-58.

Karpicke, J. D., Blunt, J. R., Smith, M. A., & Karpicke, S. S. (2014). Retrieval-based learning:

The need for guided retrieval in elementary school children. *Journal of Applied Research in Memory and Cognition*, 3, 198-206.

Landrum, R. E. (2013). *Undergraduate writing in psychology: Learning to tell the scientific story* (revised edition). Washington, DC: American Psychological Association.

Marsh, E. J., Meade, M. L., & Roediger, H. L. (2003). Learning facts from fiction. *Journal of Memory and Language*, 49, 519-536.

Nunes, L. D., & Weinstein, Y. (2012). Testing improves true recall and protects against the buildup of proactive interference without increasing false recall. *Memory*, 20, 138-154.

Arrange references in alphabetical order by first author's last name.

"K" comes before "L" in the alphabet

Internet citation → Purdue University Online Writing Lab (OWL) (2014, October). *Citation Chart*. Retrieved from https://owl.english.purdue.edu/media/pdf/20110928111055_949.pdf

Roediger, H. L., & Karpicke, J. D. (2006a). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, *17*, 249-255.

Roediger, H. L., & Karpicke, J. D. (2006b). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science*, *1*, 181-210.

Roediger, H. L., Putnam, A. L., & Smith, M. A. (2011). Ten benefits of testing and their applications to educational practice. In J. Mestre & B. Ross (Eds.), *Psychology of Learning and Motivation: Cognition in Education* (pp. 1-36). Oxford: Elsevier.

Smith, M. A., Blunt, J. R., Whiffen, J. W., & Karpicke, J. D. (in press). Does providing prompts during retrieval practice improve learning? *Applied Cognitive Psychology*.

Smith, M. A., & Karpicke, J. D. (2014). Retrieval practice with short-answer, multiple-choice, and hybrid tests. *Memory*, *22*, 784-802.

Example of citation for a book → Tulving, E. (1983). *Elements of episodic memory*. New York, NY: Oxford University Press.

↑
Author and year

↑
Title (in italics)

↑
Publisher location and Publisher

If all authors are the same, and the year is the same (e.g., Roediger & Karpicke, 2006), then put them in order based on the title.

You also need to add a subscript (e.g., a, b) after the year, and use those subscripts throughout your paper.

Note that the references are double spaced with a "hanging" format. This means that the first line of each reference is left aligned, and all other lines are indented. You do not need to manually indent each extra line! Microsoft Word will do this for you.

To do this, highlight your reference section, go to Format, and then Paragraph. Under Indentation, there is a menu called special. Drop this menu down and select "Hanging."

Table 1

The table caption goes above the table. Mean judgments of learning from Experiment 1 and Experiment 2 in Smith, Blunt, Whiffen, and Karpicke (in press)

	Period 1	Period 2
Experiment 1		
Reading control	64.7 (19.9)	67.8 (17.0)
Free – Free	52.0 (21.7)	56.0 (25.4)
Prompted – Prompted	56.5 (21.0)	65.3 (22.5)
Prompted – Free	52.0 (24.2)	58.3 (21.6)
Free – Prompted	55.5 (22.3)	57.3 (23.0)
Experiment 2		
Reading control	-----	70.6 (23.1)
Free Recall	-----	62.7 (23.7)
Prompted Recall	-----	66.5 (22.8)

Note. Standard deviations are reported in parentheses.

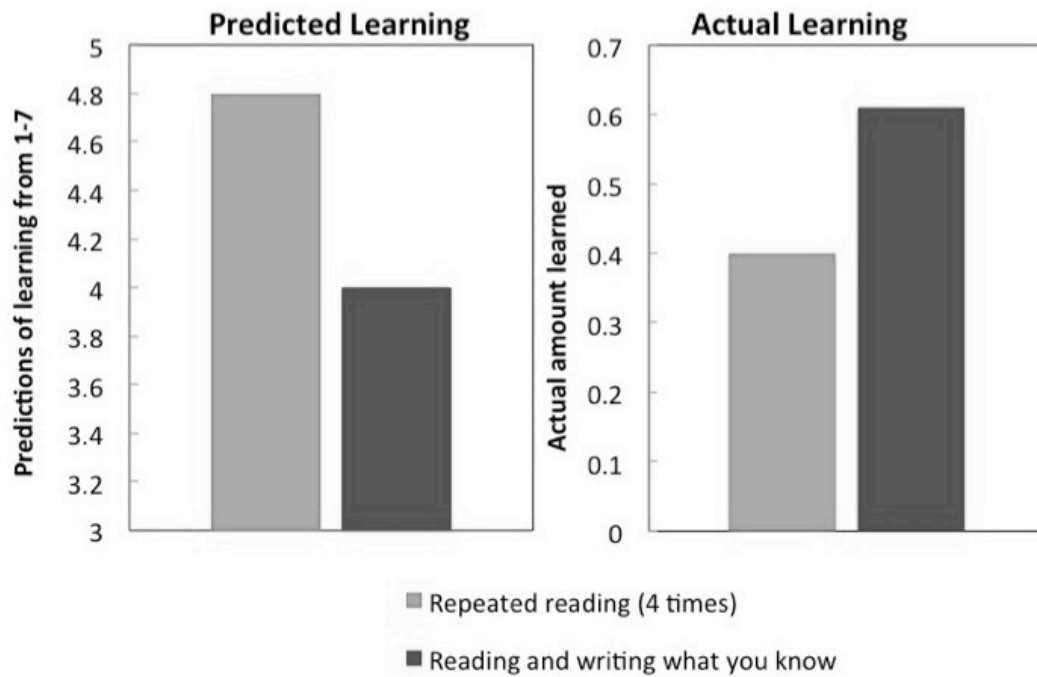


Figure 1. The figure caption goes below the figure. This figure depicts some of the data from Roediger and Karpicke (2006a), Experiment 2. Data show mean predictions of how much students would be able to recall, and mean proportion of actual idea units recalled on a final test after a one-week delay for repeated reading and reading and recalling (or writing what you know) groups. This figure has been redrawn for the purposes of this sample paper.

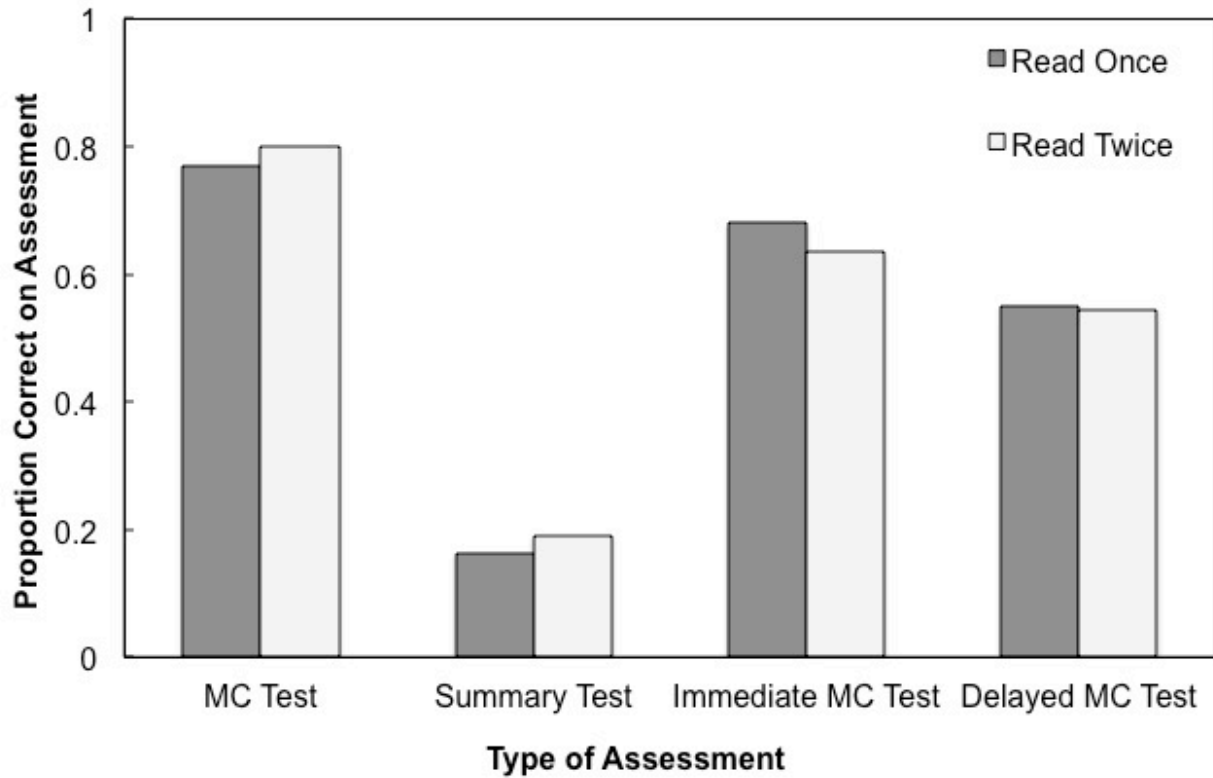


Figure 2. This figure depicts data reported in Callender and McDaniel (2009), Experiments 3 and 4. Data show proportion correct on multiple-choice (MC) and summary test final assessments after college students read a textbook passage once or twice. Data are collapsed across different types of texts (e.g., social psychology, biopsychology, green-house gasses).

Appendix

(This Appendix was taken from Smith & Karpicke, 2014)

Sample texts, and sample questions with response alternatives (multiple-choice format only). The correct response is typed in bold. (V) denotes a verbatim question; (I) denotes an inference question. The feedback corresponding to each question is also listed below.

Venice (first two paragraphs)

Venice is the capital of the region of Veneto and the province of the same name located in northeast Italy. At the heart of the city lies the “Centro Historico” (Historic Center), a mass of buildings and winding canals that has been inhabited since the 5th century A.D. Roughly 62,000 people live in this neighborhood that stretches across numerous small islands in the marshy Venetian Lagoon.

The majority of inhabitants, some 208,000 people, live on the land around the lagoon called “Terraferma” making the total population of the city much larger. In addition to bordering the Adriatic Sea, the saltwater lagoon stretches along the shoreline between the mouths of the Po and the Piave rivers. The abundance of water on all sides makes boats the primary mode of transportation for much of the citizens of Venice.

(V) What sea does the lagoon surrounding the city of Venice border?

- 1. The Adriatic Sea**
2. The Sargasso Sea
3. The Baltic Sea
4. The Aegean Sea
5. The Black Sea

Feedback statement: The lagoon surrounding the city of Venice borders the Adriatic Sea.

(I) What is the total population of Venice?

1. 160,000 people
2. 530,000 people
3. 420,000 people
4. 350,000 people
- 5. 270,000 people**

Feedback statement: The total population of Venice is 270,000 people.

The Sun

The Sun today is a yellow dwarf star. It is fueled by thermonuclear reactions near its center that convert hydrogen to helium. The Sun has existed in its present state for about 4 billion, 600 million years and is thousands of times larger than the Earth.

By studying other stars, astronomers can predict what the rest of the Sun’s life will be like. About 5 billion years from now, the core of the Sun will shrink and become hotter. The surface temperature will fall. The higher temperature of the center will increase the rate of thermonuclear reactions. The outer regions of the Sun will expand approximately 35 million miles, which is about the distance to Mercury. The Sun will then be a red giant star. Temperatures on the Earth will become too hot for life to exist.

Once the Sun has used up its thermonuclear energy as a red giant, it will begin to shrink. After it shrinks to the size of the Earth, it will become a white dwarf star. The Sun may throw off huge amounts of gases in violent eruptions called nova explosions as it changes from a red giant to a white dwarf.